

## New Rissooidea from Bulgaria (Gastropoda: Rissooidea)

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### > Abstract

For the first time a troglobiont species of the genus *Bythinella* and a representative of the genus *Radomaniola* have been found in Bulgaria. In addition, three more *Bythinella* spp., two new *Grossuana* spp. and three new *Belgrandiella* spp. could be introduced. These species are here described as new: *Bythinella markovi* n. sp., *B. ravnogorica* n. sp., *B. walkeri* n. sp., *B. srednogorica* n. sp., *Belgrandiella dobrostanica* n. sp., *B. bachkovoensis* n. sp., *B. zagoraensis* n. sp., *Radomaniola bulgarica* n. sp., *Grossuana thracica* n. sp., and *G. angeltsekovi* n. sp. Information about the habitat and photos of the type localities are also presented.

### > Kurzfassung

**Neue Hydrobiidae aus Bulgarien (Gastropoda: Rissooidea).** – Erstmals wurden eine troglobionte *Bythinella* und ein Vertreter der Gattung *Radomaniola* in Bulgarien gefunden. Zusätzlich zu drei weiteren *Bythinella*-Arten, konnten drei neue *Belgrandiella*-Arten sowie zwei neue *Grossuana* spp. vorgestellt werden. Die Arten werden hier neu beschrieben als: *Bythinella markovi* n. sp., *B. ravnogorica* n. sp., *B. walkeri* n. sp., *B. srednogorica*, *Belgrandiella dobrostanica* n. sp., *B. bachkovoensis* n. sp., *B. zagoraensis* n. sp., *Radomaniola bulgarica* n. sp., *Grossuana thracica* n. sp. und *G. angeltsekovi* n. sp. Informationen zum Habitat und Photos der Typuslokalitäten werden ebenfalls präsentiert.

### > Key words

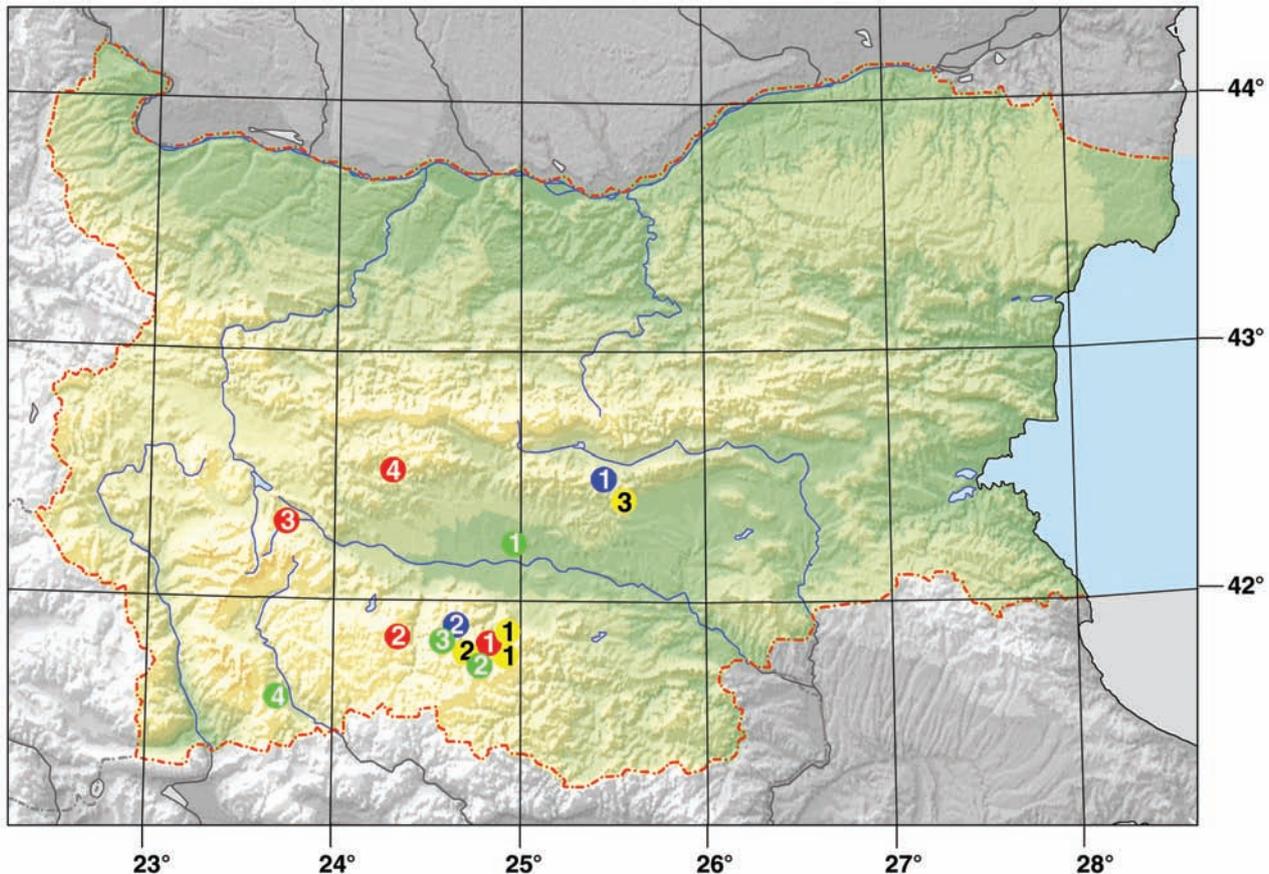
Bulgaria, Hydrobiidae, *Bythinella markovi* n. sp., *Bythinella ravnogorica* n. sp., *Bythinella walkeri* n. sp., *Bythinella srednogorica* n. sp., *Belgrandiella dobrostanica* n. sp., *Belgrandiella bachkovoensis* n. sp., *Belgrandiella zagoraensis* n. sp., *Radomaniola bulgarica* n. sp., *Grossuana thracica* n. sp., *Grossuana angeltsekovi* n. sp.

## Introduction

The hydrobiid species of Bulgaria have as yet not been studied thoroughly, although the first publication on molluscs, due to Frivaldzky, appeared in 1835 (cited after WOHLBEREDT 1911: 169). WOHLBEREDT (1911) gave a detailed summary of the literature prior to 1911, and he listed the species described by the said authors. He and his predecessors did not report on any small hydrobiid species and dealt predominantly with terrestrial snails. In the 20<sup>th</sup> century WAGNER (1927: 281) thoroughly studied the Hydrobiidae for the first time. He reported on some *Pseudamnicola* spp., of which only *P. consociella euxina* Wohlberedt, 1927 occurs in Bulgaria (loc. typ. near Varna), however, RADOMAN (1983: 58–59) mentioned this species as belonging to the genus *Adriohydrobia* Radoman, 1973.

HUBENOV (2007) and ZETTLER (2008) mentioned *Grossuana codreanui* (Grossu, 1946) as a regional endemic species (northern Black Sea coast), while ANGELOV (2000: 12) and RADOMAN (1983: 58–59, mentioned as *G. serbica codreanui*) believed that it was widely distributed in the Balkans. In addition ANGELOV (2000) and HUBENOV (2007) listed some small hydrobiid species of the genus groups *Belgrandiella* and *Pontobelgrandiella* from Bulgaria, which are locally endemic.

The species we discuss here belong to the genus groups *Bythinella* Moquin-Tandon, 1855, *Belgrandiella* Wagner, 1927, *Radomaniola* Szarowska, 2006 (formerly *Orientalina* Radoman, 1978), and *Grossuana* Radoman, 1973.



**Fig. 1.** The sampling sites of the Hydrobiidae of Bulgaria. *Bythinella* (red dot): 1: *B. markovi* n. sp. (Gargina Dupka Cave); 2: *B. ravnogorica* n. sp. (Ravnogor); 3: *B. walkeri* n. sp. (Rila Mts); 4: *B. srednogorica* n. sp.; *Radomaniola* (blue dot): 1: *R. bulgarica* n. sp.; 2: *R. rhodopensis* n. sp.; – *Grossuana* (green dot): 1: *G. thracica* n. sp. (Chirpan Bunar Cave); 2–4: *G. angelitsekovi* n. sp. (2: Bachkovo; 3: Pavelsko; 4: Musomishta), – *Belgrandiella* (yellow dot): 1: *B. dobrostanica* n. sp. (Gargina Dupka Cave), 2: *B. bachkovoensis* n. sp. (Bachkovo), 3: *Belgrandiella zagoraensis* n. sp. (Stara Zagora).

The species of the genus *Bythinella* are widely distributed from the uplands of Germany (BOETERS 1981) and Poland (FALNIOWSKI 1987) on the northern border, to the Mediterranean and Northern Africa (KRISTENSEN 1985) in the South. The eastern border is the Ukraine (SON 2009), and Turkey limits the distribution in the S-East (YILDIRIM 1999, 2006).

Species of the genus *Bythinella* occur predominantly in springs and spring-fed brooks, and as they are photophobic, they live on the undersides of leaves or submerged wood, in the interstitial (BOETERS 1998), or, exceptionally, also in caves (*Bythinella padiraci* Locard, 1902), and prefer temperatures of 6–10° C.

From Bulgaria only three *Bythinella* spp. are known until now: *B. austriaca* (Frauenfeld, 1856), *B. hansboetersi* Glöer & Pesič 2006, and *B. cf. opaca* (Gallenstein, 1848) (GEORGIEV & STOYCHEVA 2008). *Bythinella austriaca* has been listed by ANGELOV (2000) and HUBENOV (2007) as well, but has not been mentioned by RADOMAN (1983), who was the outstanding expert on the Hydrobiidae of the Balkans. GEORGIEV & STOYCHEVA (2008) already put in question the occurrence of *B. austriaca* in Bulgaria.

Species determination in the genus *Bythinella* is problematic, because species that are anatomically distinct cannot be distinguished genetically (*B. robiciana* (Clessin, 1890) vs. *B. opaca* (Gallenstein, 1848) HAASE et al. (2007)). On the other hand, species that differ only by the marginal teeth of the radula, a constant feature, (*B. angelitae* Haase, Wilke & Mildner, 2007 vs. *B. opaca*) can be distinguished by sequencing CO1 fragments (HAASE et al. 2007). Thus it is uncertain whether *B. opaca* is distributed in Bulgaria or whether it is a distinct species such as *B. angelitae*, which can only be distinguished genetically or by the radula from *B. opaca*.

The *Belgrandiella* species listed by ANGELOV (2000) only occur in the Stara Planina Mts and Kraishte Mts. From the Rhodopes Mts, where we found the new species, *Belgrandiella* spp. are unknown so far. The new species do not belong to the genus *Pontobelgrandiella* Radoman, 1978, because the penis of *Pontobelgrandiella* has two small outgrowths on the left side, which could not be found in the *Belgrandiella* spp. which are discussed here.

Species of the genus *Radomaniola* and *Grossuana* have not been mentioned by ANGELOV (2000) from Bulgaria, except *Grossuana codreanui* (Grossu, 1946), listed as a *Pseudamnicola*.

Species of the genus *Radomaniola* and *Grossuana*, which are discussed here, are problematic concerning their classification. SZAROWSKA et al. (2007) discussed the species *Grossuana codreanui* (Grossu, 1846), *G. serbica* (Radoman, 1973), *Belgrandiella haesitans* (Westerlund, 1881), and *Orientalina delphica* Radoman, 1973, considering their generic position, and they found that all these species, however, belong to the genus *Grossuana*.

This paper is intended (i) to improve the knowledge concerning the Hydrobiidae in Bulgaria, and (ii) to describe the new species *Bythinella markovi* n. sp., *B. ravnogorica* n. sp., *B. walkeri* n. sp., *B. srednogorica*, *Belgrandiella dobrostanica* n. sp., *B. bachkovoensis* n. sp., *B. zagoraensis* n. sp., *Radomaniola bulgarica* n. sp., *Grossuana thracica* n. sp., and *G. angeltsekovi* n. sp.

## Material and methods

In 2008–2009 D. Georgiev collected freshwater molluscs in Bulgaria. The snails were collected by hand and with a sieve from the waters. The samples were put into 75% ethanol. The dissections and measurements of the genital organs and the shells were carried out using a stereo microscope (Zeiss); the photographs were made with a digital camera system (Leica R8).

Of every species we dissected three specimens to be sure that the morphology of the penis and the flagellum is a constant feature.

## Results

New samples, collected in the years 2008 and 2009 by D. Georgiev, revealed some new species of the Hydrobiidae in Bulgaria.

Genus: *Bythinella* Moquin-Tandon, 1856

*Bythinella markovi* n. sp.

**Material examined:** 17 ex. from type locality, collected 26.02.2009 by D. Georgiev.

**Holotype:** Shell height 2.15 mm, width 1.25 mm, ZMH 51442.



**Fig. 2.** The type locality of *Bythinella markovi* n. sp. (below: inside the cave).

**Paratypes:** 2 specimens ZMH 51443, 3 juvenile specimens for DNA sequencing in the University of Gießen (Prof. Wilke), rest in collection Glöer.

**Locus typicus:** In the stream of Gargina Dupka cave (=Crow Whole cave), near the village of Mostovo, the northern slope of the Rhodopes Mts, Southern Bulgaria, N 41° 51' 00.4" E 24° 55' 57.1", 915 m alt.

**Etymology:** Named after Tanyo Markov, a speleologist who led D. Georgiev to this cave.

**Description:** The horn-coloured shell is cylindrical and consists of 3.5–4 whorls, which are regularly convex with a deep suture. The surface is silky and finely striated. The apex is obtuse, the umbilicus closed. The aperture is oval with a sharp periostome, which is slightly thickened at the columella. Shell height 2–2.2 mm, width 1.2–1.3 mm, aperture height to shell height 0.47–0.50.

**Animal:** The mantle is white. The penis is as long as the penial appendix (Fig. 3.3), the flagellum is regularly broad, at the proximal end slightly thickened (Fig. 3.4).

**Distribution:** Gargina Dupka cave is a part of the very large Dobrostan karst system that has a total of 77 registered caves, and adjacent areas of the vil-



**Fig. 3.** *Bythinella markovi* n. sp. 1: photographed in ethanol (holotype), 2: paratype, 3: penial appendix with flagellum (penis cut), 4: penis in situ. – fl = flagellum, p = penis, pa = penial appendix.

lages as Mostovo, Dobrostan, Pavelsko, Borovo, and Orehovo (PETROV & STOEV 2007). Many of the caves in this ridge have waters, possibly connected somewhere underground. So *B. markovi* possibly inhabits a larger area of subterranean streams and rivers, and the edge of its populations can be expected to lie in other caves.

**Notes on the ecology:** The cave has two closely situated entrances and a stream that flows out from the lower one. There is a catchment of its waters at the cave antechamber which drives away about 70% of the stream for drinking needs. The total cave length is 524 m (PETROV & STOEV, 2007). The specimens live under stones in a limestone cave stream, which has shallow (at average around 10–15 cm) and calm waters in winter and summer, and deep (max about 1–1.5 m) and fast running ones at rainy seasons (Markov, pers. comm.). Live specimens were collected 50 meters from the cave's entrance, where the environmental conditions were characteristic for a cave. There was no light entering, air temperature 6.6° C, and that of the water 9.6° C with oxygen level of 9.0 mg/l. Living snails were found along the whole stretch of the stream up to the surfacing of the stream from a narrow cave whole, close to the cave's end. At the cave's middle parts there was a large mound of guano beneath a large bat colony, and close to the stream. At this area the oxygen in the stream dropped a little to 8.8 mg/l, the water temperature was similar, while the air warmed to 10.3° C. The only makro invertebrate animal species found to live with *B. markovi* were flat worms *Planaria* sp. which could be the only predator of the snails. Taking 117 at random 2×2 cm<sup>2</sup> square samples (14.03.2009) from under stone surfaces in the stream, we collected a total of 16 individuals of *B. markovi* which showed a relative density of 0.14 individuals per 2 cm<sup>2</sup> (min-max = 0–2 individuals).

**Recommendations for conservation measures:** Noting that the only population of *B. markovi* known till now occupied only a few meters of a cave stream, we consider it as very vulnerable. Accordingly, we recommend a full protection of the habitat and the species by law. Now it has a law statute of a “natural landmark” and a water spring for drinking needs and the cave is partly protected, having a metal grating at the entrance that, unfortunately, does not prevent various people from entering and disturbing the area. We also recommend to the speleologists and cavers who enter the cave to avoid walking into the stream, and to move on the dry areas to avoid crushing individuals of *B. markovi*.

#### *Bythinella ravnogorica* n. sp.

**Material examined:** 14 ex. from type locality.

**Holotype:** Shell height 2.9 mm, width 1.6 mm, ZMH 51444.

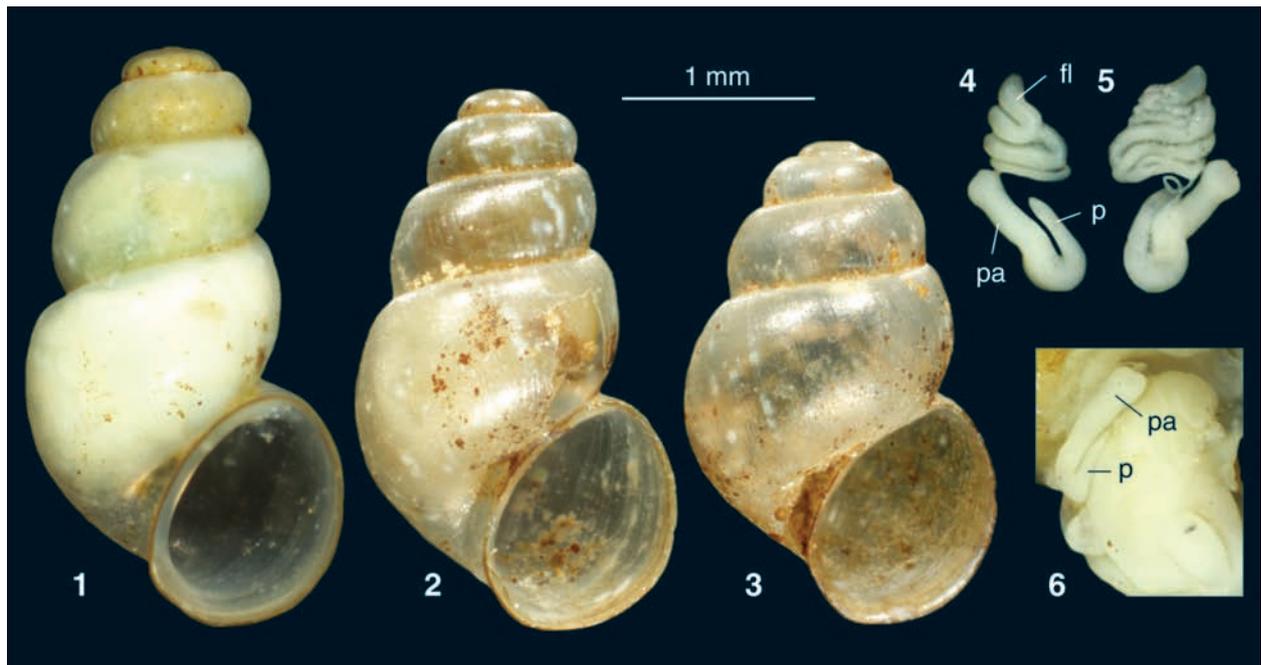
**Paratypes:** 3 ex. ZMH 51445, rest in collection Glöer.

**Locus typicus:** West Rhodopes Mts, village of Ravnogor, N 41° 56' 59.9" E 24° 21' 53.3", 1250 m alt.

**Etymology:** named after the Ravnogor village where the species was found.

**Description:** The colourless shell is cylindrical and consists of 4–4.5 whorls which are regularly convex with a deep suture. The surface is silky and finely striated. The apex is obtuse, the umbilicus is opened. The aperture is oval with a sharp periostome. Shell height 2.9–3.1 mm, width 1.6–1.9 mm, aperture height to shell height 0.38–0.42.

**Animal:** The mantle is white. The penis is by one quarter shorter than the penial appendix (Fig. 4.3), the flagellum is regularly broad, at the proximal end



**Fig. 4.** *Bythinella ravnogorica* n. sp. **1:** photographed in ethanol (holotype), **2–3:** paratype, **4–5:** penis with flagellum (**4:** dorsal view, **5:** ventral view), **6:** penis in situ. – **fl** = flagellum, **p** = penis, **pa** = penial appendix.



**Fig. 5.** The type locality of *Bythinella ravnogorica* n. sp. from two views.

slightly thickened (Fig. 3.4) and very thin at the distal end (Fig. 4.4).

**Notes on the ecology:** Spring from a small limestone whole in an open grassy terrain, under stones and dead wood, 8° C. We found specimens of *B. ravnogorica* mostly under small pieces of submerged dead wood at the place of emerging of the spring water from a small cave gap. The upper surfaces of the substrates (stones, dead wood) from under which we collected the animals were fully covered by a thick population of green algae.

**Distribution:** known only from the type locality, where the limestone formed a specific “island” among a large granite area, probably endemic species.

**Recommendations for conservation measures:** The type locality spring is situated very close to a dairy farm that strongly pollutes the waters of the main river (Ravnogorska River), of which the spring is a tributary. Also a lot of plastic, organic and other garbage was observed around the area of finding *B. ravnogorica*, so we recommend adequate measures to put a check to the water pollution of the area. We believe that a single chemical agent could destroy the whole population of the species from the type locality.



**Fig. 6.** *Bythinella walkeri* n. sp. **1:** photographed in ethanol (holotype), **2–3:** paratypes, **4:** penis in situ, **5:** penis and flagellum. fl = flagellum, p = penis, pa = penial appendix.

*Bythinella walkeri* n. sp.

**Material examined:** 18 ex. from type locality.

**Holotype:** Shell 3.2 mm high, width 1.9 mm; ZMH 51446.

**Paratypes:** 3 ex. ZMH 51447, rest in collection Glöer.

**Locus typicus:** Rila Mts, south of Dolna Banya village near Bistrizta River, N 42° 15' 59.3" E 23° 43' 48.7", 831 m alt.

**Etymology:** Named after our colleague David Walker who polished the English in many of the papers of the senior author.

**Description:** The whitish to yellowish shell is cylindrical and consists of 4–4.5 whorls that are regularly convex and flattened at the deep suture. The surface is silky and finely striated. The apex is obtuse, the umbilicus is closed. The aperture is oval with a sharp peristome. Shell height 3.0–3.2 mm, width 1.9–2.0 mm, aperture height to shell height 0.43–0.44.

**Animal:** The mantle is pigmented in black. The penis is by one half shorter than the penial appendix (Fig. 5.3), the flagellum is regularly broad, at the proximal end thickened (Fig. 3.4) and tapered at the distal end (Fig. 5.4).

**Distribution:** Known only from the type locality, but it might be expected in numerous non-isolated springs similar to the type locality in Rila and other neighbouring mountains.

**Notes on the ecology:** Shallow spring, 1–3 cm, from granite rocks; total lack of limestone in the area, in *Fagus sylvatica* forest. Non calcereous species occurring in shallow spring filled with leaves and wood rotting matter.



**Fig. 7.** The type locality of *Bythinella walkeri* n. sp.

**Recommendations for conservation measures:** This species was registered at the edge of the “Rila” National Park. This area is known as highly endangered by rapidly developing tourist resorts, an activity that totally destroys the primeval woods.

*Bythinella srednogorica* n. sp.

**Material examined:** 18 ex. from type locality.

**Holotype:** Shell height 2.9 mm, width 1.7 mm, ZMH 51448.

**Paratypes:** 3 ex. ZMH 51449, rest in collection Glöer.

**Locus typicus:** Sredna Gora Mts, west of the village of Djulevo, south of Streltcha town, close to Streltchenska Luda Yana River, in a stream flowing into it with a small pond near to its spring (the gastropods were



**Fig. 8.** *Bythinella srednogorica* n. sp. 1: photographed in ethanol (holotype), 2–3: paratype, 4: penis with flagellum. – fl = flagellum, p = penis, pa = penial appendix.

found only in the running water), UTM-grid: KH80, GPS coordinates: 42°27'15.6" N, 24°20'27.1" E, 393 m a. s. l.

**Etymology:** named after the mountain Sredna Gora where this species lives.

**Description:** The horn-coloured shell is cylindrical and consists of 4.5 whorls that are regularly convex with a deep suture. The surface is silky and finely striated. The apex is obtuse, the umbilicus is slit-like. The aperture is oval, angled at the top, with a thickened periostome. Shell height 2.9–3.1 mm, width 1.6–1.7 mm, aperture height to shell height 0.44–0.42.

**Animal:** The mantle is dark grey. The penis has a relatively rounded apex and a broader base. The penial appendix is wide at the upper part, and the corpus is a little protruded. The penis is as long as the penial appendix (Fig. 6.3), the flagellum is extraordinarily large with a thin distal part and a thick proximal part.

**Notes on the ecology:** *Bythinella srednogorica* n. sp. has been found in a small stream, flowing from beneath a limestone hill and passing by a volcanic rock, which is a tributary of a medium sized river (Streltchenska Luda Yana). The stream was surrounded by a forest of *Carpinus orientalis* and *Quercus* sp.

### Genus *Belgrandiella* Wagner, 1927

The species of the genus *Pontobelgrandiella* Radoman, 1978 have two nipple-like outgrowths on the left side of the penis, the penis of *Belgrandiella* spp.

have no outgrowths. Thus the species described below belong to the genus *Belgrandiella*.

### *Belgrandiella angelovi* Pintér, 1968

**Locus typicus:** "Bulgarien, Balkan-Gebirge (Stara Planina), eine Quelle im Schipka-Paß, nördlich vom gleichnamigen Dorf."

**Description:** The colourless to greenish-yellowish shell is opaque, cylindrical and consists of 4–4.5 regularly growing whorls that are slightly rounded with a weak suture. The surface is silky. The apex is slim and obtuse, the umbilicus is slit-like. The aperture is ovally broad. Shell height 1.9 mm, width 0.98 mm (holotype), aperture height to shell height 0.39.

### *Belgrandiella zagoraensis* n. sp.

**Material examined:** 27 ex. from type locality, 29.11.2008 D. Georgiev et Stoycheva leg.

**Holotype:** Shell height 1.8 mm, width 1.1 mm, ZMH 51454.

**Paratypes:** 3 ex. ZMH 51455, rest in collection Glöer.

**Locus typicus:** Spring near Bedechka River, park "Krairechen", town of Stara Zagora.

**Etymology:** Named after the town in which region the species lives.

**Description:** The yellowish to brownish shell is cylindrical and consists of 4.5–5 whorls that are slightly rounded with a clear suture. The surface is silky to glossy. The apex is slim and obtuse, the umbilicus



Fig. 9. Paratype of *Belgrandiella angelovi* (HNHM Budapest No. 11885).

is closed. The aperture is oval. Shell height 1.8–2.0 mm, width 1.1–1.2 mm, aperture height to shell height 0.40.

**Animal:** The mantle is white, the penis is simple without an appendix and regularly broad.

**Notes on the ecology:** Could be found on stones and moss.

**Recommendations for conservation measures:** The population of *R. bulgarica* in the town of Stara Zagora is endangered by the nowadays very fast growing urbanisation of the area, which at last can totally destroy its habitat. We recommend entire protection of the area and the conservation of the forest habitat in the town as it was years before. Also careful control on water pollution is needed. The type locality of the species is endangered by a total diversion of the waters of the thermal spring for commercial purposes, so this has to be avoided.

#### *Belgrandiella dobrostanica* n. sp.

**Material examined:** 20 ex. from type locality, 14.03.2009 D. Georgiev leg., 8 ex. West Rhodopes near Martsiganitsa Hut, spring at karst area in *Fagus sylvatica* forest, N 41°53'14.1", E 24°53'6.5", 02.05.2009 Georgiev leg.

**Holotype:** Shell height 1.8 mm, width 0.9 mm, ZMH 51450.

**Paratypes:** 3 ex. ZMH 51451, rest in collection Glöer.

**Locus typicus:** Gargina Dupka cave, about 20 m from the entrance, Mostovo village, N 41° 51' 0.4" E 24° 55' 57.1", 915 m alt.

**Etymology:** Named after the Dobrostan Ridge of the Western Rhodopes where the species was found.

**Description:** The whitish to light horn-coloured shell is cylindrical and consists of 4.5–5 whorls that are slightly rounded with a weak suture. The surface is



Fig. 10. *Belgrandiella zagoraensis* n. sp. 1: shell, 2: penis in situ.

silky to glossy. The apex is slim and obtuse, the umbilicus is closed. The aperture is oval and angled at the top. Shell height 1.7–1.9 mm, width 0.9–1.0 mm, aperture height to shell height 0.37–0.40.

**Animal:** The mantle is white, the penis is simple without an appendix, and at the distal end tapered.

**Distribution:** known only from the type locality, probably endemic.

**Notes on the ecology:** Water temperature measured on 14.03.2009 was 8.2°C and oxygen levels – 9.4 mg/l. Possibly troglophilous species.

**Recommendations for conservation measures:** same like for *Bythinella markovi*.

#### *Belgrandiella bachkovoensis* n. sp.

**Material examined:** 23 ex. from type locality, 15.03.2009 D. Georgiev et S. Stoycheva leg.

**Holotype:** Shell height 2.1 mm, width 1.0 mm, ZMH 51452.

**Paratypes:** 3 ex. ZMH 51453, rest in collection Glöer.

**Locus typicus:** Bachkovo village, West Rhodopes, stream, N 42° 57' 10.1" E 24° 51' 41.2", 320 m alt.

**Etymology:** Named after the village in which region the species lives.

**Description:** The colourless to light horn-coloured shell is cylindrical and consists of 4.5–5 whorls that are slightly rounded with a weak suture. The surface is glossy. The apex is small and obtuse, the umbilicus closed. The aperture is oval. Shell height 1.9–2.0 mm, width 1.0–1.1 mm, aperture height to shell height 0.40–0.42.

**Animal:** The mantle is colourless, the penis is simple without an appendix, and at the distal end slightly tapered.

**Notes on the ecology:** It lives in a small stream that is 40–50 cm in length and 5–10 cm in depth, passes



Fig. 11. *Belgrandiella dobrostanica* n. sp. 1: photographed in ethanol (holotype), 2–3: paratype, 4: penis in situ.



Fig. 12. *Belgrandiella bachkovoensis* n. sp. 1: holotype, 2: penis in situ.

through granite rocks, situated beneath a large limestone area. It is surrounded by grass vegetation and single *Populus* sp., *Salix* sp. and *Juglans regia* trees. Water temperature of the spring was 6.4° C (measured on 15.03.2009), and oxygen – 9.2 mg/l. Co-existing with *Galba truncatula*.

**Recommendations for conservation measures:** Pollution of the type locality by a small animal farm situated upstream was obvious, and has to be limited.

#### Genus *Radomaniola* Szarowska, 2006

The species of the genus *Radomaniola* have a clearly visible outgrowth at the left side of the penis, like the species described here as new. Species of the genus *Grossuana* Radoman, 1973, a genus which is closely related to *Radomaniola*, have smaller outgrowths, sometimes hardly visible. If both genus groups are distinct in fact can be discussed.



Fig. 13. The type locality of *Belgrandiella bachkovoensis* n. sp.

#### *Radomaniola bulgarica* n. sp.

**Material examined:** 35 ex. from type locality, collected 15.11.2008 by D. Georgiev.

**Holotype:** Shell height 1.8 mm, width 1.3 mm, ZMH 51456.

**Paratypes:** 5 ex. ZMH 51457, rest in collection Glöer.

**Locus typicus:** Thermal spring south of the village of Ostra Mogila, southern slope of Sarnena Sredna Gora Mts, Southern Bulgaria. N 42° 27' 10.8" E 25° 28' 27.5", 368 m alt.

**Etymology:** Named after the country where the species lives.



Fig. 14. *Radomaniola bulgarica* n. sp. 1: shell photographed in ethanol (holotype), 2: paratype, 3: Penis.

**Description:** The elongated conical shell is light horn-coloured to whitish and consists of 4–4.5 whorls that are slightly convex with a clear suture. The surface is silky. The apex is small rounded, the umbilicus is closed. The aperture is oval and angled at the top, with a sharp periostome which is at the columella thickened. Shell height 1.7–1.8 mm, width 1.2–1.3 mm, aperture height to shell height 0.49–0.50.

**Animal:** The mantle is pigmented in black with a white border. The penis bears a double lobe on its left edge that is pigmented by two small black spots and a triangular black pigmented spot at the distal end to it (Fig. 4.3). The operculum is orange (Fig. 4.2).

**Distribution:** Except at the type locality, we registered the species in four springs at Bedechka River (a few kilometers east of the type locality) both in the Upper Thracian Lowland at the town of Stara Zagora town, and up the same river at the slopes of the Sarnena Sredna Gora Mts.

**Notes on the ecology:** Thermal spring. Water temperature 17.2° C at the spring, oxygen 6.2 mg/l, 368 m alt. (measured on 19.04.2009). Known to live in calcareous small, very shallow springs that are inflows of medium sized rivers, surrounded by tree vegetation as *Alnus glutinosa*, *Salix* spp., and *Populus* spp. The population in the town of Stara Zagora (Upper Thracia) is situated in a stream in a forest park area. The springs at Bedechka River are colder with a water temperature of 10° C, and filled with tree leaf detritus having oxygen levels of 5.2 mg/l. In these springs *R. bulgarica* lives together with *Belgrandiella angelovi* on stones, sand, wood and water vegetation.

**Recommendations for conservation measures:** The population of *R. bulgarica* in the town of Stara Zagora is endangered by the nowadays very fast growing urbanisation of the area, which at last can totally destroy its habitat. We recommend entire protection of the area and the conservation of the forest habitat in the town as it was years before. Also careful control on water pollution is needed. The type locality of the species

is endangered by a total diversion of the waters of the thermal spring for commercial purposes, so this has to be avoided.

**Remark:** GEORGIEV (2005) reported *R. bulgarica* as *Pseudamnicola consociella euxina* from shell material collected near the type locality.

#### *Radomaniola rhodopensis* n. sp.

**Material examined:** 39 ex. fro ocality, 15.03.2009 D. Georgiev et S. Stoycheva leg.

**Holotype:** Shell height 1.9 mm, width 1.5 mm, ZMH 51533.

**Paratypes:** 5 ex. ZMH 51534.

**Locus typicus:** a small spring (water source), tributary of the Pavelsko village main river, south of the village, N 41° 51' 9.7" E024° 42' 29.4", 791 m alt.

**Etymology:** named after the Rhodopes (= Rodopi, Rhodope) mountains where the species lives.

**Description:** The conical shell is light horn-coloured to whitish and consists of 4–4.5 whorls that are slightly rounded with a weak suture. The surface is silky. The apex is slightly rounded, the umbilicus closed. The body whorl is prominent. The aperture is oval and angled at the top, with a sharp periostome which is thickened at the columella. Shell height 1.9–2.1 mm, width 1.5–1.6 mm, aperture height to shell height 0.43–0.45.

**Animal:** The mantle is pigmented in black with a white border. The penis bears a double lobe on its left edge and a black pigmented spot at the distal end of it. The operculum is orange.

**Notes on the ecology:** Lives in spring that are visibly rich in calcium (the CaCO<sub>3</sub> was formed a thick stratum on the stone surfaces and sticking the stones together as a cement) with a lot of rotting plant matter with temperature 8.4° C, and oxygen 7.2 mg/l. The spring was filled mainly with dead leaves of *Juglans regia*, growing nearby. type 1.



Fig. 15. *Radomaniola rhodopensis* n. sp. 1–2: shell.



Fig. 16. The type locality of *Radomaniola rhodopensis* n. sp.



Fig. 17. Type locality of *Grossuana thracica* n. sp. from two views.

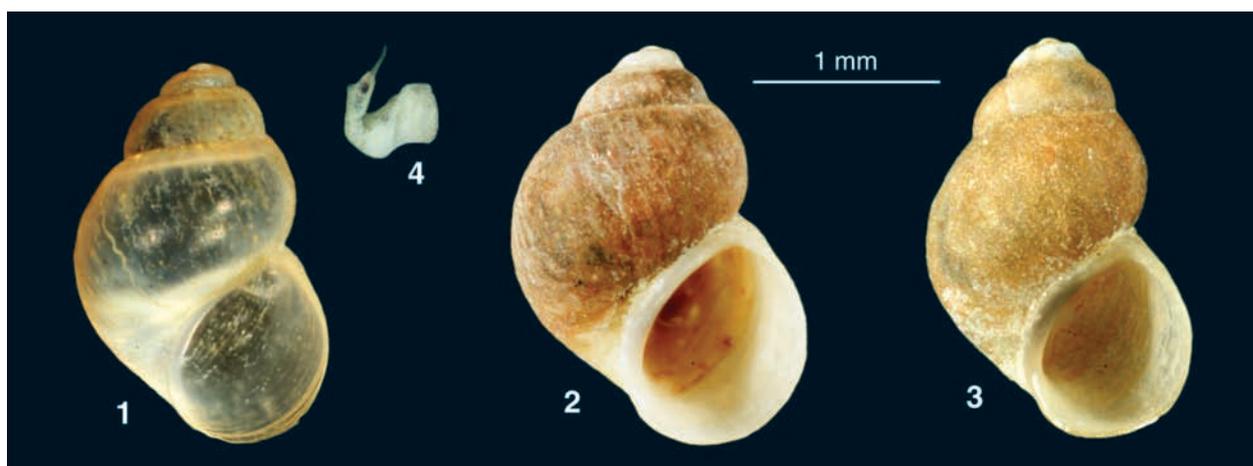


Fig. 18. *Grossuana thracica* 1: shell photographed in ethanol (holotype), 2–3: paratypes, 4: penis.

Genus *Grossuana* Radoman, 1973

*Grossuana thracica* n. sp.

**Material examined:** 57 ex. from type locality, collected 06.12.2008 by D. Georgiev.

**Holotype:** Shell height 2.1 mm, width 1.2 mm, ZMH 51458.

**Paratypes:** 5 specimens in ethanol, ZMH 51459, rest in collection Glöer.

**Locus typicus:** It lives where the water emerges from the spring of Chirpan Bunar cave, flowing into a small pond, 3 km east of the village of Bolyarino, Upper



Fig. 19. *Grossuana angeltsekovi* n. sp. 1: holotype, 2: Musomishta, 3: Pavelsko, 4: penis in situ.



Fig. 20. Type locality of *Grossuana angeltsekovi* n. sp. from two views.

Thracian Lowland, Southern Bulgaria, N 42° 13' 59", E 25° 05' 03.2", 155 m alt.

**Habitat:** Karst spring at a cave hole.

**Etymology:** Named after the region where the species lives.

**Description:** The conical to elongated conical shell is light horn-coloured and consists of 4.5 whorls that are slightly rounded with a weak suture. The surface is glossy. The apex is very small, the umbilicus closed. The aperture is oval and slightly angled at the top, with a sharp peristome that is thickened at the columella. Shell height 2.1–2.2 mm, width 1.5–1.7 mm, aperture height to shell height 0.53–0.60.

**Animal:** The mantle is pigmented in black with a small white border. The penis is slim and at the distal part attenuated. A small lobe is hardly visible in some specimens (n=5). A black spot on the penis seems to be characteristic.

**Notes on the ecology:** Limestone lowland area, running surface water emerging from a cave and filling a small pond. The type locality is the actual spring of a small river surrounded by pastures and agricultural

lands, collected from stones and water vegetation. Water temperature 13° C (measured on 06.12.2008). Co-existing with *Radix auricularia*.

**Recommendations for conservation measures:**

Considering that *G. thracica* is connected only with a few meters of spring area in one of the few lowland caves of Upper Thracia, we found it very vulnerable. Accordingly we recommend full protection of the area and the species by law. Quick measure has to be taken to prevent the entrance of cattle (mainly cows) from the nearby villages into the wetland area, which can destroy the population of the species. Also the pumping from the pond for irrigating the nearby agricultural lands has to be limited. The use of pesticides has to be carefully controlled.

*Grossuana angeltsekovi* n. sp.

**Material examined:** 8 ex. from type locality; 6 ex. from a spring (22° C) at village Musomishta, Mesta River Valley, Toplitzata area, N41° 33', E023° 45',

28.03.2009 A. Tsekov leg., 20 ex. (4 adults, 16 juveniles) from Pavelsko village, West Rhodopes, spring at the river south of the village, 15.03.2009 Georgiev et Stoycheva leg.

**Holotype:** Shell height 2.1 mm, width 1.5 mm; ZMH 51460.

**Paratypes:** 3 ex. from type locality; ZMH 51461.

**Locus typicus:** Bachkovo village, W Rhodopes, spring in sand, N41° 57' 8.5" E024° 51' 37.3", 303 m alt, 15.03.2009 D. Georgiev leg.

**Etymology:** Named after Prof. Angel Tsekov, an ichthyologist who collected the material from Musomishta village area.

**Description:** The elongated conical shell is whitish to light horn-coloured and consists of 5–5.5 whorls that are slightly rounded with a weak suture. The surface is glossy. The apex is very small, the umbilicus closed. The aperture is oval and slightly angled at the top, with a sharp periostome, which is thickened at the columella. Shell height 2.0–2.1 mm, width 1.3–1.4 mm, aperture height to shell height 0.40–0.42.

**Animal:** The mantle is pigmented in black with a small white border. The penis is slim and at the distal part strongly tapered, with a black spot on the middle part of the penis.

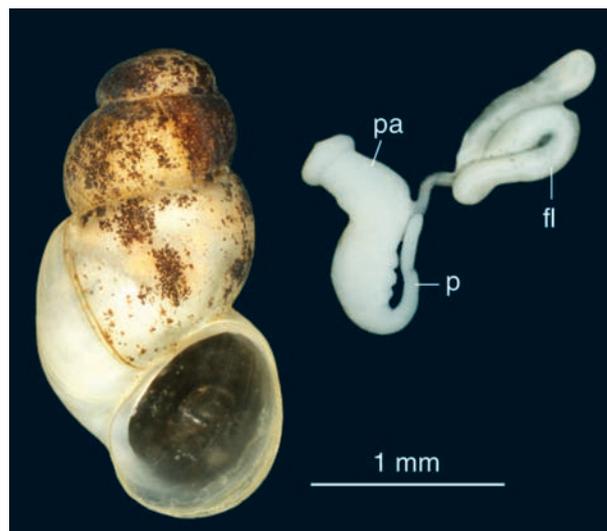
**Notes on the ecology:** The water temperature at the Bachkovo water source was 12° C, oxygen was 9.3 mg/l, at Pavelsko they were respectively 8.2° C, and 8.4 mg/l. Possibly calcereous species, because it was found at areas of visibly calcium rich waters. Lives in small rivers and springs with various temperatures.

**Recommendations for conservation measures:** Sustainable and regulated usage of the spring waters of the species localities is needed for their conservation.

## Discussion

According to our experience delimitation of species is possible if they are distinct in at least one constant feature which allows separation from other species, because this shows, that the speciation is fixed. Classification of genus groups is possible, if the species differ in their basic penis morphology and shell characters as well.

The genus *Bythinella* is well-defined by a cylindrical shell and a penis that bears a penial appendix with a flagellum. The penis of *Bythinella markovi* is concerning the ratio of the penis and penial appendix, similar to that of *B. austriaca*, but the flagellum differs from *B. austriaca*'s. In addition, the mantle of *B. austriaca* is pigmented in black (white in *B. markovi*), and *B. austriaca* does not occur in caves. It seems that the specimens of *B. markovi* n. sp. studied by us are



**Fig. 21.** *Bythinella opaca* (topotype). – fl = flagellum, p = penis, pa = penial appendix.

not fully grown. *B. markovi* is clearly distinct from *Bythinella opaca*, as can be told by considering the penis morphology, because the penis of *B. opaca* is longer than the penial appendix, and the flagellum is slimmer than in *B. markovi*. From *B. hansboetersi* the new species is different in the penis morphology (penis is shorter and the flagellum is slim and long) as well as in the shell's proportions, in *B. markovi* shell width to height is about 0.47–0.50 and in *B. hansboetersi* it is 0.59–0.61. The other new *Bythinella* spp. that are described here can also be distinguished by means of the penis morphology and the flagellum. The flagellum seems to be a good feature to distinguish *Bythinella* species. *Bythinella srednogorica* was mentioned as *Bythinella* cf. *opaca* (GEORGIEV et STOYCHEVA 2008), and the authors already questioned if this is in fact *B. opaca*. The flagellum in *B. opaca* is much shorter than in *B. srednogorica*, the proportions of shell height to width is in *B. srednogorica* 0.55 and 0.53 in *B. opaca*, thus *B. opaca* is slimmer than *B. srednogorica*.

The *Belgrandiella zagoraensis* n. sp. is the only *Belgrandiella* sp. under discussion, of which the outer margin of the aperture is vertical, in the other species the last whorl grows a little upward, thus, however, their outer margin of the aperture are louvered. In addition, the shell of *B. zagoraensis* is not opaque like the others'. In *B. dobrostanica* n. sp. as well as in *B. bachkovoensis* the umbilicus is closed versus slit-like in *B. angelovi*. *B. bachkovoensis* n. sp. is broader than the other *Belgrandiella* spp. under discussion. The outer margin of the other species' aperture is sinuated (from side view) versus straight in the here discussed *Belgrandiella* spp. (see PINTÉR 1968).

The genus groups *Radomaniola* and *Grossuana* are probably not well defined (SZAROWSKA et al. 2007), but we follow RADOMAN (1983: 39, Fig. 17) who described

the penis of the genus *Radomaniola* [Orientalina], which bears a double lobe at its left edge, which is clearly visible. The genus *Radomaniola* is not known from Bulgaria so far, but RADOMAN (1983) reported on *Radomaniola* spp., which occur regionally or locally endemic in Montenegro, Serbia and Greece. In Radoman's opinion (1983: 41) the species *Amnicola miliaria* Frauenfeld, 1863 and *Pseudamnicola consociella* Frauenfeld, 1863, which have been listed by ANGELOV (2000) and HUBENOV (2007) from Bulgaria, are synonyms of *Radomaniola curta* (Küster, 1852). *Pseudamnicola consociella* has been described as a species with an elongated conical shell with its type locality in Dalmatia, and *Pseudamnicola miliaria* has also been described from Dalmatia. Because the shells of these species are similar to *P. consociella*, Wagner mentioned it as being a subspecies of the latter one.

The genus *Grossuana* is defined by a penis that bears a small lobe at the left edge, which is hardly visible. In addition the distal part of the penis is tapered (RADOMAN 1983: 56 Fig. 24). RADOMAN (1983: 40–41) reported on the distribution of *Grossuana codreanui* from S-Romania and Bulgaria to Serbia (e.g. region of Niš), while ANGELOV (2000) and HUBENOV (2007) mentioned this species as being a regional endemic species (coastal region of the Black Sea). *G. thracica* n. sp. differs from *G. codreanui* in the penis morphology (the penis of the latter species is not strongly tapered as it is in *G. thracica*) and the shell of *G. codreanui* is glossy vs. silky in *G. thracica* n. sp. In addition, the aperture of *G. codreanui* is rounded oval and not angled at the top, as it is in *G. thracica*. Both *Grossuana* spp. are locally or regionally endemic species but *Grossuana angeltsekovii* n. sp. is widely distributed in Bulgaria and could be found in the Mesta River Valley as well as in the Rhodopes Mts (see Fig. 1).

Usually, species of the subfamily Risssooidea, which occur in mountainous regions, are locally or regionally restricted in their distribution. On the other hand, many species have been described in former times from the Balkan region, but only a few from Bulgaria. Thus we assume that the species diversity in Bulgaria is higher as known as yet, and we hope that it can be studied before the habitats of endangered unknown species are destroyed.

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## References

- ANGELOV, A. M. (2000): Mollusca (Gastropoda et Bivalvia) aquae dulcis. – Catalogus Faunae Bulgaricae **4**. Sofia, Leiden, Pensoft & Backhuys Publishers. xiv + 57 pp.
- BANK, R. A. (in press): Towards a catalogue and bibliography of the freshwater Mollusca of Greece. – *Heldia* **6**(1/2): 79–112.
- BOETERS, H. D. (1981): Die Gattung *Bythinella* Moquin-Tandon in Deutschland (Prosobranchia). – *Archiv für Molluskenkunde* **111**: 191–205.
- BOETERS, H. D. (1998): Mollusca: Gastropoda: Superfamilie Risssooidea. In: SCHWOERBEL, J. & ZWICK, P. (Hrsg.): Süßwasserfauna von Mitteleuropa (begründet von A. BRAUER), **5**(1, 2). Stuttgart, G. Fischer. IX+76 S.
- FALNIOWSKI, A. (1987): Hydrobioidea of Poland (Prosobranchia: Gastropoda). – *Folia Malacologica*, **1**: 1–119.
- GEORGIEV, D. (2005): Species diversity and habitat distribution of the malacofauna (*Mollusca: Bivalvia, Gastropoda*) of Surnena Sredna Gora Mountain (Southern Bulgaria). In: B. GRUEV, M. NIKOLOVA, A. DONEV (Eds.): Proceedings of the Balkan Scientific Conference of Biology in Plovdiv (Bulgaria) from 19<sup>th</sup> till 21<sup>st</sup> of May 2005. pp. 428–435.
- GEORGIEV, D. & STOYCHEVA, S. (2008): A record of *Bythinella* cf. *opaca* (Gallenstein, 1848) (Gastropoda: Prosobranchia: Hydrobiidae) in Bulgaria. – *Malacologica Bohemoslovaca* (2008) **7**: 51–54.
- HAASE, M., WILKE, TH. & MILDNER, P. (2007): Identifying species of *Bythinella* (Caenogastropoda: Risssooidea): A plea for an integrative approach. – *Zootaxa* **1563**: 1–16.
- HUBENOV, Z. (2007): Fauna and Zoogeography of Marine, Freshwater, and Terrestrial Mollusks (Mollusca) in Bulgaria. – In: FET, V. & POPOV, A. (Eds.): Biogeography and Ecology of Bulgaria. Springer. pp. 141–198.
- KRISTENSEN, T. K., 1985. Guide pratique des Gastéropodes d'eau douce Africains. Espèces présentes en Afrique. 21 pp., 9 pl.
- LOCARD, A. (1902): Description de mollusques nouveaux appartenant à la faune souterraine de France et d'Italie. – *Bulletin du Muséum d'Histoire naturelle [de Paris]*, **8**: 608–611.
- PETROV B. & STOEV P., 2007. The Underworld of the Rhodopes. U&D Ltd. Graphic Design Company Publ., Bulgaria. 86 pp. [In Bulgarian].
- PINTÉR, L. (1968): Eine neue Wasserschnecke aus Bulgarien. – *Archiv für Molluskenkunde* **98**(1/2): 61–63.
- RADOMAN, P. (1983): Hydrobioidea a superfamily of Prosobranchia (Gastropoda). I. Systematics. – *Serbian Academy of Sciences and Arts, Monographs* **547** (Department of Sciences, 57): 1–256.
- SON, M. (2009): Check-list of freshwater Gastropoda of Ukraine (<http://malacologukraine.narod.ru/Check-list-gastropoda-freshwater.htm>, 2009).
- SZAROWSKA, M., GRZMIL, P., FALNIOWSKI, A. & SIRBU, I. (2007): *Grossuana codreanui* (Grossu, 1946) and the phylogenetic relationships of the East Balkan genus *Grossuana* (Radoman, 1973) (Gastropoda: Risssooidea). – *Hydrobiologia* DOI 10.1007/s10750-006-0530-4. Springer Science+Business Media B. V.
- WAGNER, A. (1927): Studien zur Molluskenfauna der Balkanhalbinsel mit besonderer Berücksichtigung Bulgariens und Thraziens, nebst monographischer Bearbeitung einzelner Gruppen. – *Annales Zoologici Musei Polonici* **6**(4): 263–399, 23 pl.
- WOHLBEREDT, O. (1911): Zur Molluskenfauna von Bulgarien. – *Abhandlungen der Naturforschenden Gesellschaft zu Göttingen* **27**: 167–234.
- YILDIRIM, M. Z. (1999): Türkiye Prosobranchia (Gastropoda: Mollusca) Türleri ve Zoorafik Yayılımları. 1. Tatlı ve Acı Sular. – *Turkish Journal of Zoology* **23**: 877–900.
- YILDIRIM, M. Z. (2006): Supplement to the Prosobranchia (Mollusca: Gastropoda) Fauna of Fresh and Brackish Waters of Turkey. – *Turkish Journal of Zoology* **30**: 197–204.
- ZETTLER, M. L. (2008): Two records of the regional endemic hydrobiid snail *Grossuana codreanui* (Grossu, 1946) in Bulgaria (Dobruja) and some nomenclatorial notes. – *Mollusca* **26**: 163–167.